



# Tube Bundle Fires at ETTP

## *An Historical Retrospective*

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# Introduction

|                      |                                    |
|----------------------|------------------------------------|
| <b>Subject::</b>     | <b>Tube Bundle Fires</b>           |
| <b>Contractor:</b>   | <b>BNFL</b>                        |
| <b>DOE Office:</b>   | <b>Oak Ridge Operations Office</b> |
| <b>ORO Coord:</b>    | <b>Brenda Hawks</b>                |
| <b>OE Personnel:</b> | <b>Richard Day and Steve Zobel</b> |



# Background

- ✍ Buildings K-31 and K-33 were designed as part of the Oak Ridge Gaseous Diffusion Process
- ✍ Functional unit was made up of compressor and a converter
- ✍ D&D activities were begun in 1998



## Background (cont'd)

- ✍ Converters consist of an outer steel shell, two end caps and an interior tube bundle
- ✍ A tube bundle consists of thousand of nickel tubes held in place by circular tube sheets
- ✍ Converters are dismantled in the K-33 D&D workshop



## Background (cont'd)

- ✍ Hazards associated with converter dismantlement include Uranium exposure, nuclear criticality, and industrial.
- ✍ Converters are cut using a plasma torch.
- ✍ Two man crew (cutter and fire watch) is required.

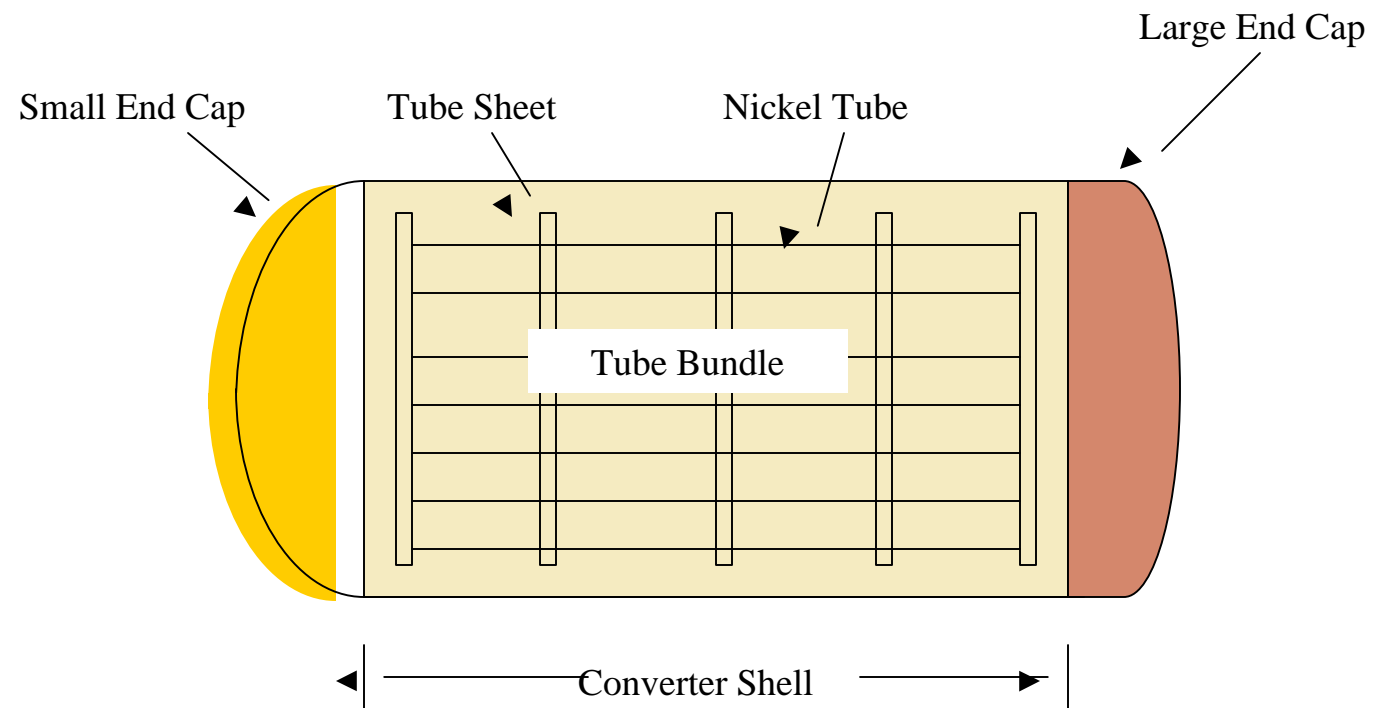


# Event Description

- ✍ **Dismantlement of converters began in 1999.**
- ✍ **Process consists of the following:**
  - Small end cap removal
  - Large end cap removal
  - Removal of tube bundle
  - Dismantlement of tube bundle



# Simplified Converter





## Event Description (first fire)

- ✍ **April 4, 2000**
- ✍ **An exposed tube bundle was dismantled.**
- ✍ **The fire occurred while cutting the tube sheet.**
- ✍ **The cutter angled the torch towards the tube bundle.**
- ✍ **Notice of Violation was issued with a civil penalty of \$41,250**





## Event Description (second fire)

- ✍ July 25, 2001
- ✍ Removal of the small end cap
- ✍ Cut location not specified in EWP
- ✍ Hazard associated with a design feature not analyzed
- ✍ Enforcement Conference held July 2, 2002



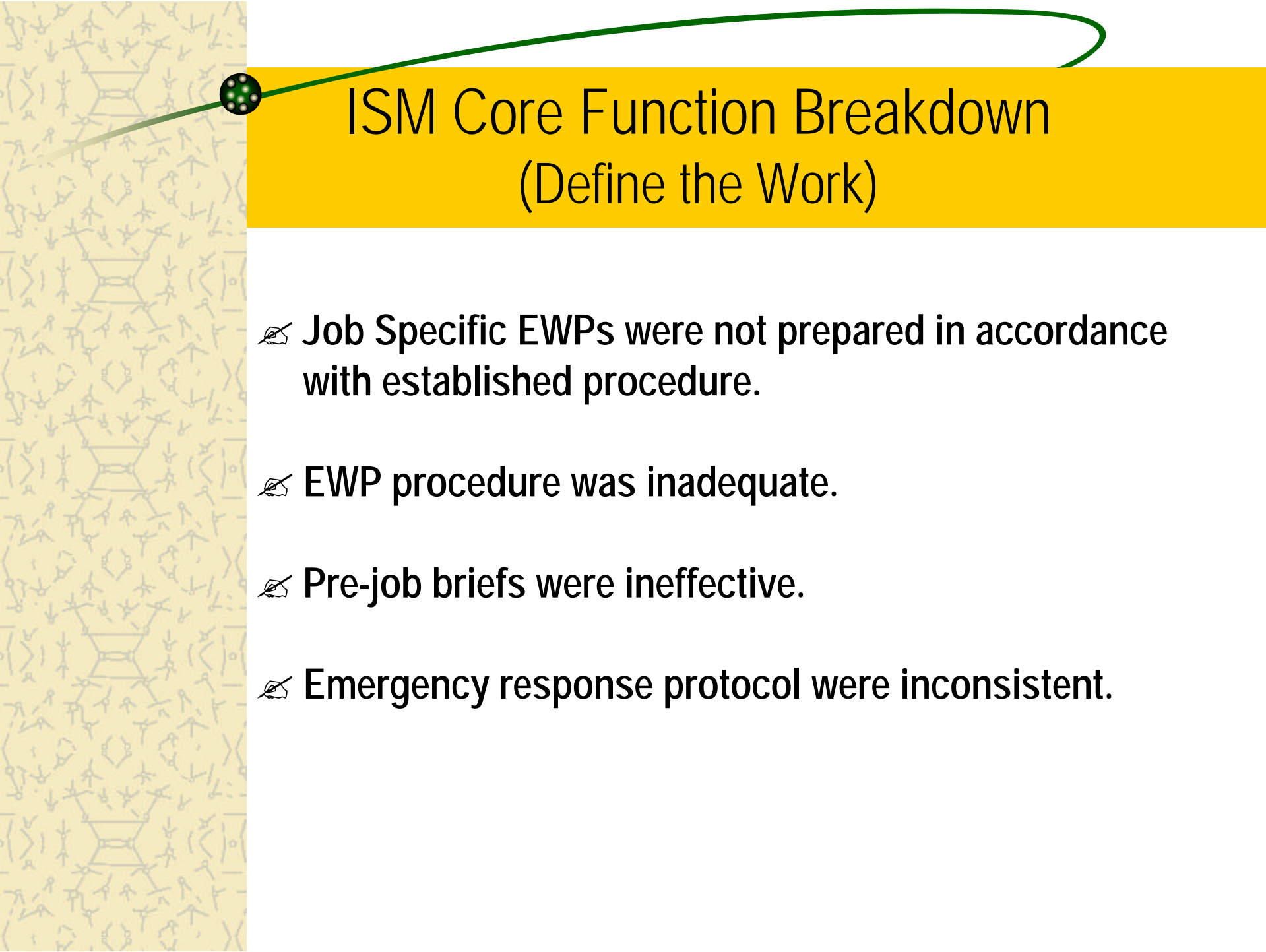
## Event Description (third fire)

- ✍ June 27, 2002
- ✍ Cutting of welded brackets attached to tube bundle prior to bundle removal from converter shell
- ✍ Hazard controls associated with cutting of brackets not identified
- ✍ Type B Accident Investigation conducted
- ✍ Enforcement Conference held November 22, 2002



## ISM Core Function Breakdown (Define the Work)

- ✍ Missions are translated into work, expectations are set, tasks are identified and prioritized, and resources are allocated
- ✍ At ETTP mission related activities are translated into work through the Enhanced Work Planning (EWP) process
- ✍ Expectations are set in pre-job briefings
- ✍ Emergency response protocol is established in procedure and the job specific EWP



## ISM Core Function Breakdown (Define the Work)

- ✍ Job Specific EWP's were not prepared in accordance with established procedure.
- ✍ EWP procedure was inadequate.
- ✍ Pre-job briefs were ineffective.
- ✍ Emergency response protocol were inconsistent.



## ISM Core Function Breakdown (Analyze and Control the Hazards)

- ✍ Hazards associated with the work are identified, analyzed and categorized.
- ✍ Applicable standards and requirements are identified and agreed-upon, controls to prevent/mitigate hazards are identified, the safety envelop is established, and controls are implemented.
- ✍ Hazards and controls associated with converter dismantlement are identified in the Basis for Interim Operation, Fire Hazards Analysis, and the job specific EWP.







## ISM Core Function Breakdown (Analyze the Hazards)



- ✍ **The job specific EWP failed to adequately identify and control the hazards associated with the job evolution:**
  - Changes to the EWP were not analyzed (first fire).
  - EWP team failed to recognize the hazard associated with a known design feature (second fire).
  - Hazard controls associated with a change to the EWP were not identified or implemented (third fire).
  - Hazard identification and control associated with “R&D” approach to converter dismantlement were not analyzed.







## ISM Core Function Breakdown (Perform Work Safely)

- ✍ Readiness is confirmed and work is performed safely.
- ✍ Step-by-step requirements to perform a given job evolution are stated in the job specific EWP.
- ✍ Interviews with BNFL personnel demonstrated a consistent lack of knowledge of the requirements stated in the job specific EWP.






## ISM Core Function Breakdown (Perform Work Safely)

- ✍ **BNFL personnel failed to following requirements stated in the job specific EWP:**
- Torch not angled properly (first fire and second fire)
  - Converter cut in wrong location (second fire)
  - Steps performed out of sequence (third fire)



## ISM Core Function Breakdown (Perform Work Safely)

-  **BNFL personnel emergency response to the tube bundle fires were inconsistent with established protocol:**
- Fire Department personnel were not informed that they were responding to a metal fire and were not equipped to fight the fire (first fire).
  - Fire Department personnel were told they could use water to fight the metal fire contrary to protocol (second fire).
  - Direction was given to Fire Department personnel from BNFL personnel other than the person in charge (second fire).



## ISM Core Function Breakdown (Perform Work Safety)

- ✍ HEPA filter was turned off upon exiting the area contrary to protocol (second fire).
- ✍ BNFL personnel attempted to fight the fire contrary to instruction in the EWP to pull the alarm box and immediately leave the area (third fire).
- ✍ Fire Department personnel could only locate one of the required two Class D extinguishers (third fire).



## ISM Core Function Breakdown (Feedback and Improvement)

- ✍ Feedback information on the adequacy of controls is gathered, opportunities for improving the definition and planning of work are identified and implemented, line and independent oversight is conducted, and if necessary, regulatory actions occur.
- ✍ The job specific EWPs have a section which is to be used to identify lessons learned from previous activity. This section of the EWP failed to adequately capture operating experience gained from previous metal fires.





## ISM Core Function Breakdown (Feedback and Improvement)

- ✍ BNFL Management and Independent Assessment of converter disassembly operations was lacking in both frequency and depth of analysis.
- ✍ The BNFL corrective action management process was lacking in terms of the quality of their accident investigation, root cause analysis, corrective actions identification and implementation, and timeliness of corrective action closure.





# Conclusions

- ✍ BNFL has demonstrated some improvement (i.e., EWP development, accident investigation).
- ✍ Issues remain in hazard identification and control, worker knowledge of EWPs, emergency response, and corrective action management.
- ✍ Converter disassembly does involve considerable risk in terms of unknown associated with converter design.
- ✍ The three previous fires were all preventable.



# Notes